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VERIFICATION OF TRANSLATION

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I verify that the attached English translation is a true and correct translation made by me of the attached specification in the German language of International Application PCT/EP2003/010518;

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: February 16, 2005MWR Turner

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Wind power installation

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5 Wind power installation technology has seen dramatic developments  
in the last 20 years. In the meantime there are installations of the order of  
magnitude of up to 5 MW and future development leads to an expectation  
of installations with an even greater nominal power. The present application  
does not preferably concern such megawatt installations but rather small  
10 installations, in particular a small wind power installation of between about  
50 and 150 kW nominal power, which can be set up practically at any  
location in the world as independently as possible of intensive machine  
support.

Hitherto, for the production of the wind power installations, it is usual  
15 for individual components of the wind power installation, for example the  
pylon, the rotor, the rotor blades, the generator, the machine casing, the  
transformer, the control electronics and so forth to be transported  
individually to the erection location, and assembled there. In that respect,  
erection of the pylon usually requires a crane which is also needed for  
20 positioning the machine casing and for mounting the rotor and the  
generator. The individual parts of the installation are taken to the place at  
which the wind power installation is to be erected, by means of trucks.

The object of the present invention is to simplify the erection of a  
wind power installation.

25 According to the invention that object is attained by the features of  
claim 1 and a process for erecting a wind power installation having the  
features of claim 2. Advantageous developments are set forth in the  
appendant claims.

In the wind power installation according to the invention all the  
30 components thereof or all essential components are transported in one or  
more standard containers (for example 20 foot; 40 foot). The advantage of  
such standard containers is that there are sufficient transport means for  
that purpose, such as for example truck container transporters, by means

of which the containers can also be transported on land. In addition such standard containers have long been in use for shipping and accordingly the entire shipment even of a plurality of installations in a plurality of containers can be effected in a simple manner by container ships. In addition there are in the meantime many aircraft which are capable of taking a standard container as the payload in the aircraft fuselage.

With the installation according to the invention, the transport container or a plurality of such transport containers which previously have accommodated the individual components of the installation is now also used for erecting the wind power installation. Thus for example a container forms the entire foundation of the wind power installation. For that purpose such a container can be provided with a suitable connection to the base of the pylon of the wind power installation.

That can be effected on the one hand by the provision at the outside on the container of at least one flange having a row of bores, through which can be screwed screws which can then also accommodate the corresponding pylon base or pylon base flange of the wind power installation so that the pylon base of the wind power installation is then screwed to the container connection. To weight down the container so that it also represents a sufficiently high foundation weight, the container can be filled with sand, concrete, water or another medium.

The use of the container as a foundation, in accordance with the invention, has the particular advantage that an adequate foundation arrangement from the factory is thus also already supplied with the installation from the factory and, if the wind power installation is to be set up a very remote area, a foundation can be laid in a very simple manner, for which purpose hitherto a steel structure filled with concrete has usually been employed (see the book by Erich Hau, 1996 'Windkraftanlage', pages 388, 389 and 390).

In addition, in the case of the wind power installation according to the invention, the transformer and also the entire control arrangement can already be fixedly installed in the container at a predetermined location at the factory so that, after the wind power installation has been erected, it

will be brought into operation very quickly without very complicated cable connections having to be made between the generator and the control arrangement and the transformer.

It is also particularly advantageous if the wind power installation has  
5 at least one cable winch which is motor-driven or which is to be driven manually. If the cable is guided over a suitable auxiliary carrier (support frame with deflection roller) which is to be mounted to the container, at least the pylon of the wind power installation can be erected and, with a suitable further cable guide arrangement on the pylon or the machine  
10 casing, further components of the installation such as the generator, the rotor and so forth can be lifted to hub height, without the use of a building crane being required for that purpose.

In order to improve the stability and steadiness of the installation, it is also possible for firstly the container which is to form the foundation of  
15 the installation to be buried in the ground at the location at which the wind power installation is to stand, so that only the top side of the container or the upper parts of the container project out of the ground.

In order further to improve the stability and steadiness of the foundation, it can also be provided that, in the case of a container to be  
20 buried, openings are let into various side walls of the container (or have been let into the side walls in the factory), through which tubes, rods or other bracing members are then driven into the ground surrounding the container and those tubes, rods or other bracing members are then connected to the container, whether by welding, screwing, clamping or in  
25 some other fashion.

If the entire control arrangement or all essential electrical components such as control cabinets, power cabinets, transformers and so forth are already fixedly disposed at the factory in the 'foundation container' or a further container, then after the installation components  
30 have been erected, it is then only necessary to provide the cable connections between those components and the generator on the one hand and the power supply network on the other hand, so that the entire assembly procedure for the wind power installation is possible using very

simple means and the entire process of setting up the regulating equipment of the wind power installation can already be carried out at the factory.

The invention is described in greater detail hereinafter by means of an embodiment illustrated in the drawing in which:

5           Figure 1 shows a first alternative embodiment of the invention (base module),

          Figure 2 shows a view in cross-section through the container of the installation of Figure 1,

          Figure 3 shows a further alternative embodiment of the invention,

10           Figure 4 is a view in principle of the invention during the erection of the wind power installation,

          Figure 5 is a view in principle of an individual part of the wind power installation in the direction of the pylon,

          Figure 6a is a plan view of a wind setup of a container solution,

15           Figure 6b shows an alternative solution to Figure 6a,

          Figure 7a shows a view in cross-section through a container according to the invention and a lowermost pivotable pylon segment, and

          Figure 7b shows an arrangement of the pylon (Figure 7a) with inclined positioning of the container (shown in an exaggerated view).

20           Figure 1 is a view in principle of a wind power installation according to the invention comprising a rotor 1 with three rotor blades 2 which are carried by a machine casing 3 and coupled to a generator 4 in the machine casing. The entire machine casing is protected by a cladding (pod) 5 and is carried by a pylon 6 which in turn is carried by a container 7. The container  
25           in turn has an entrance 8 leading to a space (not shown) within the container 7, within which are disposed the items of equipment for controlling and regulating the installation as well as the transformer of the wind power installation, with which the electrical power produced is transformed to the network level so that the electrical power can be fed  
30           into the electrical network to which the wind power installation is connected.

          So that the container can afford adequate stability and steadiness and thus form an adequate foundation, the foundation is filled with sand or

another weighting material (for example water), where the interior is not required for any components or parts of the installation.

In Figure 1 the pylon is placed with its base on the top side of the container and screwed there. For that purpose the container has a suitable  
5 flange or a corresponding attached part which has a row of bores which is the same as a corresponding row of bores at the underside of the pylon flange so that the two parts can be fixedly screwed to each other.

The pylon comprises individual portions (sections) which are of such a length that they can still be accommodated by the container. If for  
10 example a 40 foot standard container is used, it is therefore readily possible for the individual tower sections to be of a length of about 12 m.

The further components of the machine casing or the rotor can also be individually transported within the container, in which respect it is also certainly possible for individual components to be disposed in an already  
15 pre-assembled condition within the container, for example a machine carrier together with a journal and a generator mounted thereon with its rotor and its stator so that, at the place of manufacture, the entire assembly procedure can be of the utmost simplicity.

Figure 2 shows an alternative embodiment to Figure 1, wherein the  
20 alternative is essentially that the pylon base is not fitted on to the top side of the container but that provided in the top side of the container is a receiving means, through which the lower region of the pylon can be passed so that then the pylon base can be arrested on the bottom of the container at holders provided at that location. That arresting action can  
25 again be formed by screwing or by other mechanical fixings.

A peripherally extending ring is fitted in the region of the container receiving means at the top side of the container, the ring providing for sealing the pylon and the container on the one hand, and also providing for good transmission of forces from the pylon to the container on the other  
30 hand.

Figure 3 shows a further variant of the invention where the container does not stand on the ground but is let into the ground and in addition provided in the container bottom and in the container wall therearound are

a plurality of openings through which tubes, rods or other bracing members can be driven into the surrounding earth. Those tubes, rods or bracing members are in turn connected to the container wall, for example by screwing, and provide for enhanced stability and steadiness of the wind power installation even under very rough wind conditions when very high forces have to be transmitted to the foundation.

Figure 4 is a view in principle showing how a wind power installation according to the invention can also be erected without a crane. For that purpose a cable winch 12 is mounted to the container. The cable winch can have a motor drive but it can also be operated manually (in particular with a good step-down transmission). The cable winch has a cable 13 which is fixed to the pylon of the wind power installation over a direction-changing roller 14 mounted to a support frame (further direction-changing rollers are also possible). The direction-changing roller is carried by a support frame which extends away from the container in order in that way to provide an adequate lever action for the grip on the pylon. When now the pylon is slowly raised, the pylon which initially is in a horizontal position can be slowly erected into a vertical position and is then introduced for example into a tube 15 which is fixedly let into the container. That tube 15 performs the function of a socket sleeve which later embraces the pylon insofar as it projects into the interior of the container. The tube 15 permits the pylon to be safely and securely let down into the container.

If the overall machine casing is not of an excessively large mass, then the overall machine casing can also already be mounted to the pylon itself before the pylon is erected, so that, after the pylon has been erected, all the mechanical components of the wind power installation are already in position.

If however individual parts on the machine casing or of the pod have to be conveyed to the tip of the pylon, it is advantageous if a direction-changing arrangement is mounted on the machine casing, and then individual components can be raised to the tip of the pylon by means of the direction-changing arrangement and can be fitted to the tip of the pylon.

Figure 5 shows such a structure in principle, wherein two cable rollers are carried by a suitable support arrangement mounted on the machine casing. If in addition the support arrangement is also displaceable in the direction indicated by the arrow (Figure 5), then the most widely  
5 varying components can be raised in the most widely varying planes, for example journal, generator as well as the rotor or individual rotor blades.

If a plurality of containers are required for transporting the whole of the wind power installation, they can also be connected together to develop an overall foundation, for example to define a T-shaped structure or a  
10 crossed structure, as shown in Figure 6b. If then such containers are filled with sand, concrete or water, that foundation mass is sufficient to afford an adequate foundation for the entire wind power installation.

To enhance the stability of the foundation it may certainly be appropriate to also provide stiffening members or bracing members within  
15 the container, for example from mutually opposite container walls or between adjacent container walls, so that deformation of the container due to the forces applied to the foundation is reliably avoided.

In the variant shown in Figure 6 the foundation containers are let into the ground and access for controlling and regulating parts of the wind  
20 power installation is by way of steps which are let into the container at the top side thereof and which permit a descent into the space inside the container.

It will be appreciated that it is also possible for two containers to be disposed in mutually superposed relationship, wherein the upper one forms  
25 the space in which the parts such as switching cabinets, power modules or the transformer and so forth are positioned so that the container then forms a pure 'foundation container'.

If there is sufficient internal container space, that internal space can also be used for providing the space for a relatively simple habitation:

30 For remote monitoring of the wind power installation, it is already possible for suitable telecommunication equipment (for example a satellite telephone) to be fitted to the wind power installation at the factory so that



the installation of such equipment is also no longer necessary when erecting the wind power installation.

The described wind power installation according to the invention is distinguished in that it can also be set up and assembled at the remotest  
5 location without special expensive crane equipment and that it does not even require specially trained expert personnel for the assembly procedure if the essential components are already in a finished pre-assembled condition and only have to be put together on site or if it is only necessary for individual plugs to be plugged together on site.

10 With a pylon height of between about 30 and 50 m, the wind power installation according to the invention can certainly involve a power of between 100 and 300 kW or more. It is possible to use a pylon in the form of a conventional steel tube structure as has previously already been used in wind power installations.

15 Particular advantages of the wind power installation according to the invention however are also that a foundation no longer has to be specifically built for setting up the wind power installation, but such foundation is afforded by the transport container itself, in which the individual components of the installation are transported. If the foundation  
20 container or containers is or are then provided with weighting, the design which is calculated at the factory thus ensures that operation far from any civilisation is also certain to be possible and there is no fear of the wind power installation falling down.

All tools which are required when erecting the wind power installation  
25 are also carried in the containers for transporting the individual components of the wind power installation so that erection of the wind power installation can be effected without any problems, even in countries in which such special tools are not available. Suitable replacement material (for example lubricating greases, lines, securing means, replacement modules and so  
30 forth) can also be transported in the same manner and disposed in a suitable replacement part chamber of the container.

Accordingly, for erecting the wind power installation according to the invention, it is only necessary to transport the individual containers. As

sufficient transport capacity is to be found worldwide in all countries and in particular such transport means with which standard containers can be transported are also available, transport of the wind power installation to the site for erection thereof is always guaranteed.

5           The described solution involving a wind power installation in which all components thereof are transported in containers can be supplemented by a large number of devices and elements, wherein such devices and elements are already fixedly placed in the containers at the factory – if necessary – and also all connections in respect of those devices and  
10 elements can be finished at the factory, if they require power in operation, so that operation of the devices and elements set forth hereinafter is thus possible.

By way of example the following appropriate additions to the above-described base module should be particularly mentioned: water pump,  
15 brackish water processing installation, sea water desalination installation, solar devices, either for producing hot water or for additional power generation, water tank for the storage of a given amount of water and other liquid, telecommunication apparatuses, accumulators which provide a power supply if the wind power installation is not in operation, a  
20 diesel/vegetable oil generator, a heat exchanger, an air dehydration unit for obtaining water from air, a motor or engine, a water sterilisation station, and an electrolysis apparatus for producing hydrogen. Finally it may also be appropriate for the free space which still remains in a container to be fitted with a living unit, that living unit includes a minimum  
25 standard in terms of habitation equipment which makes a stay there and self-sufficiency possible. In addition the containers may already include upon transportation thereof several 100m of power cable with suitable cable and plug connections and other material which permit the construction at least of a local network. In the event that pump power is  
30 required, it is also advantageous if several metres of hose, for example 100m and more, are also transported in containers so that water can be pumped over a certain distance.

In regard to all the above-mentioned items of equipment and elements, it can also be assumed that the overall structure and overall operational startup should be possible even if a suitable supporting technology is not available at the location of production. That means in specific terms that as far as possible all apparatuses for constructing and starting up the wind power installation and also the above-mentioned elements should also be supplied. That includes in particular also tools as well as operating instructions so that the modular system according to the invention which can be expanded by a plurality of the above-mentioned apparatuses and elements can be set in operation.

Insofar as standard containers are used and the normal stability and stiffening thereof is not adequate for them to function as a foundation for the wind power installation, those containers should already be provided at the factory in the interior thereof with a stiffening means, for example a stiffening frame or stiffening plates or stiffening structures in order to ensure the required adequate stability.

It is also appropriate for levelling devices to be provided in the container so as to ensure that the pylon of the wind power installation is set up exactly vertically. If the terrain on which the wind power installation is set up should be uneven, it is also possible for a container to be set up in an uneven position if the apparatus for receiving the pylon is adjustable to a vertical position. That can be ensured for example by the container accommodating a fixed pylon segment which is adjustable in the vertical orientation thereof, in which case after vertical orientation of that pylon segment, the pylon of the wind power installation is placed thereon. That lowermost pylon segment which is provided in the container can be fixed in its vertical orientation in the most widely varying fashions, for example by the lowermost pylon segment being concreted in position within the container or fixed to bracing members in some other fashion.

If a plurality of containers are to be joined together so as to ensure the best possible foundation structure for the wind power installation, suitable connection between the containers should also be possible, and for that purpose the appropriate devices for connecting the containers – at

whatever locations – should already be provided at the factory or the connecting elements for connecting the containers together should be supplied with the other components so that easy assembly is possible.

5 If the wind power installation according to the invention is to be set up on a rocky substratum, it is also appropriate for those materials which permit the containers to be braced to the substratum also to be transported with the wind power installation.

10 The support frame which is necessary under some circumstances for erecting the wind power installation can also be of such a configuration that under some circumstances it can be assembled in modular manner on site (bar structure) and should be suitably provided with adequate stiffening members which permit secure erection of the wind power installation. After erection of the wind power installation, the support frame can also be used to accommodate the power cable which extends from the wind power  
15 installation so that the support frame at the same time also already forms the first power mast for which the power produced by the wind power installation can be fed into the network.

If necessary, it should also be possible that solar devices can be fixed to the top side of the containers, if a photovoltaic element is used, it  
20 should be capable of being coupled to the regulating and circuitry electronics of the wind power installation so that the electrical current of the photovoltaic arrangement can be fed into the network or into the accumulators or the further items of equipment.

If necessary one of the containers can also accommodate a network  
25 transformer station which is needed for operation of a power network.

In order to permit reliable operation of the wind power installation it should always be operated in such a way that it is not operated in the limit range of its mechanical or electrical loading. Preferably therefore operation is to be recommended in a range which is between 20 and 30% or more  
30 below the mechanical or electrical limit range. Losses that this entails in terms of efficiency of the wind power installation are to be accepted in order to guarantee very long-term and almost maintenance-free operation of the wind power installation. The above-indicated concept is based on the

notion that, in the case of relatively small installations, under some circumstances a repair procedure is scarcely worthwhile or is often not possible for the most widely varying reasons. Therefore preference is to be given to reliable operation of the overall wind power installation, ahead of  
5 maximising energy generation.

For the above-mentioned reasons it is also to be provided that remote maintenance can be implemented, as far as possible.

Finally, for the wind power installation according to the invention, it is also advantageous if the variation in the very small parts, for example  
10 screws, plugs and so forth, which are required for erecting and starting up the wind power installation, is reduced to a minimum. In addition the very small parts should as far as possible be standard parts so that the furnishing of replacements for very small parts is possible at any time.

Finally the overall structure of the wind power installation should be  
15 such that damage-free dismantling of the entire installation and further transport thereof in the containers and re-use of the entire installation are also possible.

If multi-storey steel tubes are used for the pylon of the wind power installation, it is also advantageous if at least two storeys can be fitted one  
20 into the other in order in that way to dispose those storeys in the container in as space-saving manner as possible. As the pylon of a wind power installation is usually of a markedly smaller diameter at the upper end than at the lowermost end, care is therefore to be suitably taken to ensure when designing the tower that the outer diameter of the uppermost storey is less  
25 than the inside diameter of the lowermost storey of the pylon.

If possible the rotor blades should also involve outside dimensions such that at least one of the rotor blades can be fitted in a pylon portion during transport.

Units of the wind power installation such as for example the  
30 transformer, accumulators or one of the above-mentioned supplementary apparatuses and elements which are of a relatively high weight should already be fixedly anchored in the container at the factory so that, after the wind power installation has been set up, those components no longer have

to be moved in order to bring them into operation. That structure also has the advantage that all cablings and connections between those units can then already be definitively implemented at the factory. It is then only still necessary to provide for the external connection of those units of the wind power installation to the generator thereof on the one hand or to the network or other apparatuses and elements to be driven (see above) on the other hand.

For the connection, it should be possible to have recourse very substantially to plugs which are also supplied in an already prefabricated condition and which are of such a configuration that misconnection is not possible even by non-experts. That can be ensured if the plugs are of non-unitary dimensions so that a plug can be fitted together only with a single corresponding counterpart contact member. Finally, all parts which have to be manually moved should be provided with suitable gripping points so that the entire construction operation is possible with a minimum number of people, for example between 15 and 20 men.

The above-described solution according to the invention is particularly suitable for being used in research stations and remote areas and also for the construction of local networks.

The nominal power of the wind power installation should be in the range of between 50 kW and 500 kW, preferably approximately in the range of between 100 and 200 kW. As the rotor blades are also to be transported in the containers, the length thereof, insofar as the rotor blades are in one piece, is restricted to the internal dimension of the containers, in which respect it is certainly possible to provide between the hub and the wind power installation and the rotor blade root blade adaptors of a blade length which can provide for an increase in the overall diameter of the wind power installation. For regulating the wind power installation, it is possible to use all known technologies such as stall regulation or pitch, as means for fixing the rotor blades of the wind power installation. Transmission arrangements should be eliminated as far as possible in the wind power installation, it is precisely transmission arrangements in wind power

installations that represent the portal which affords by far the most frequent reason for the failure of a wind power installation.

Figure 7b shows a further alternative embodiment of the invention. In this case not only is the pylon accommodated by the container but the  
5 pylon is mounted pivotably through certain degrees of angle and can be accommodated by a chamber in the container. If now the wind power installation is erected and it is not possible for the container to be set up absolutely flat, then erection of the wind power installation with a completely vertically oriented pylon is nonetheless possible, as shown in  
10 Figure 7b. In the lower region the pylon of the wind power installation has elements with which the vertical orientation thereof can be exactly established (for example a spirit level) and when, after container placement, the lower pylon segment is vertically oriented, the corresponding container chamber can be filled with sand or concrete or  
15 another filling material so that an adequate foundation structure for the pylon is guaranteed and the entire wind power installation can be constructed on the lowermost pylon segment.

It will be self-evident that, when the lowermost pylon segment is mounted pivotably, it is also possible to provide suitable arresting devices  
20 so that, after orientation of the lowermost pylon section in a vertical position, the oriented position can be retained.